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Research Triangle Park, North Carolina

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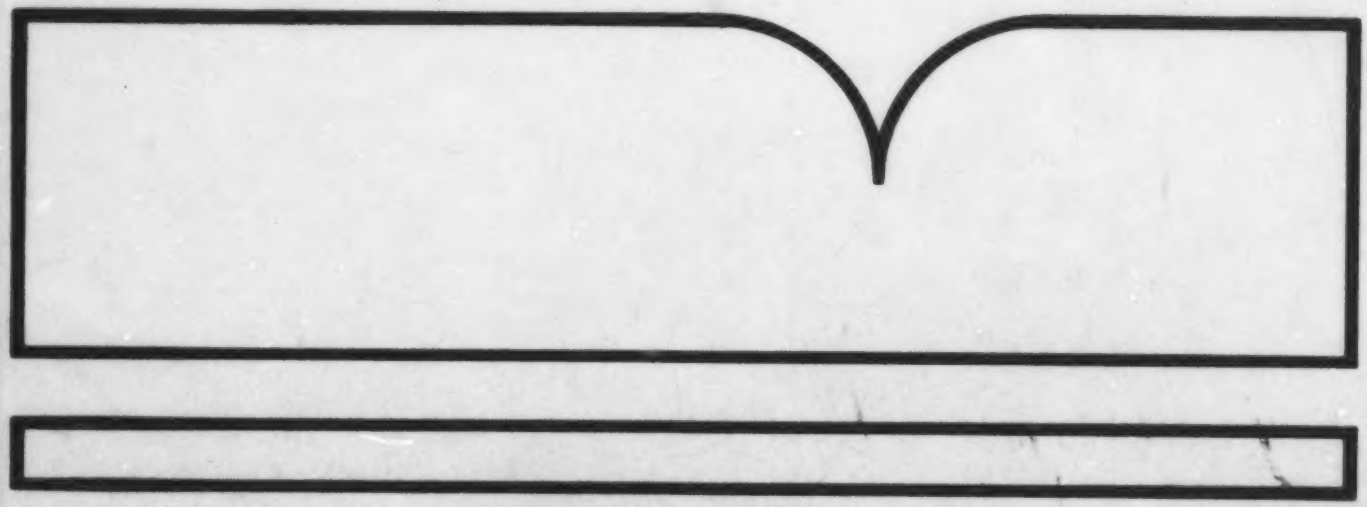

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16. ABSTRACT

This brochure contains a brief description of the Industrial Environmental Research Laboratory in Research Triangle Park. The 4 part discussion focuses on:: cleaner fuels, cleaner burning of fuels, fewer emissions, and on industrial processes.

17. KEY WORDS AND DOCUMENT ANALYSIS

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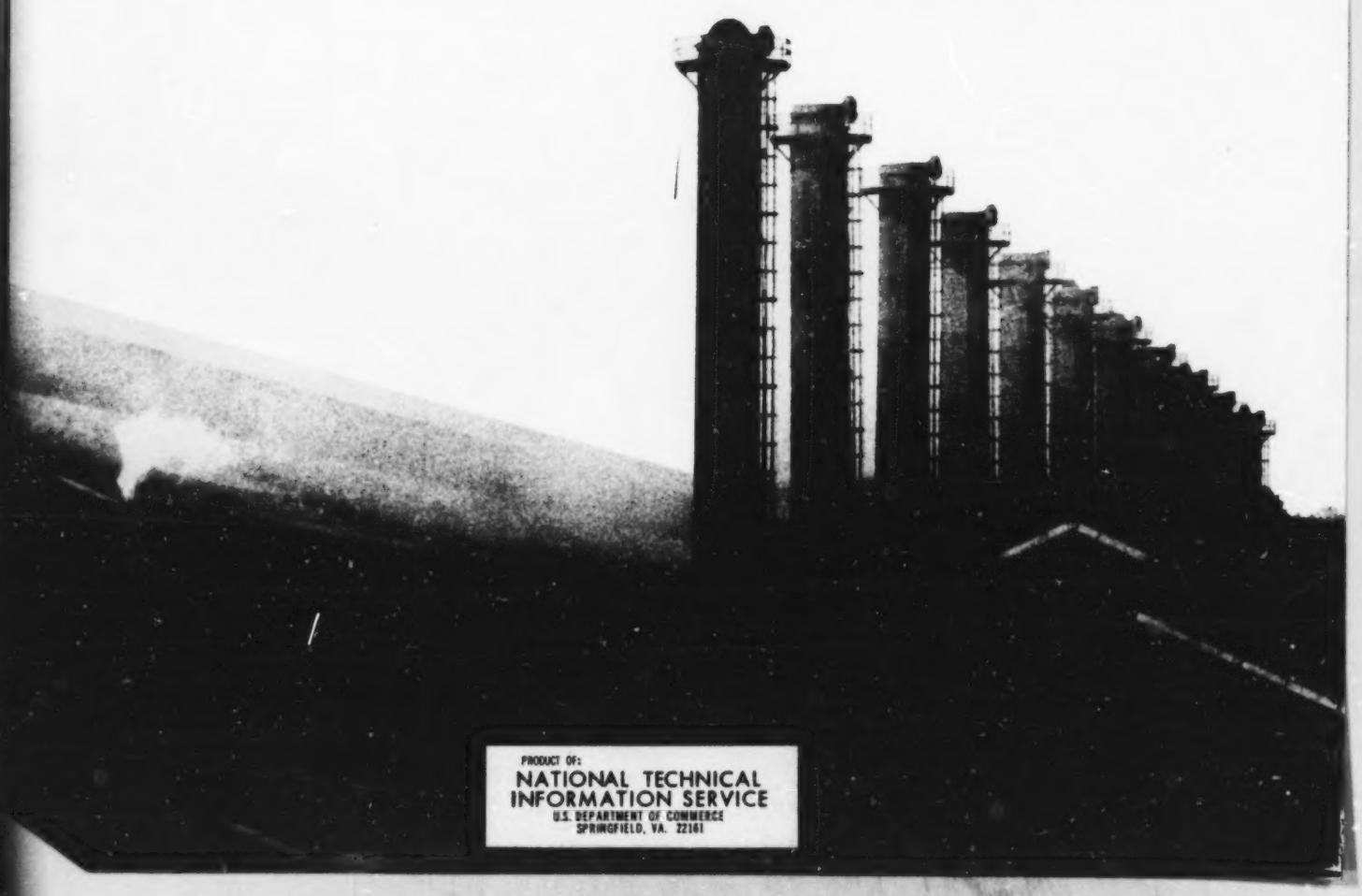

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be removed. These systems work well when the particles will easily conduct charges. However some flues, such as low-sulfur coal, produce particles which are highly-resistive to electrical charges. This laboratory is investigating alternatives, including radically new designs, to improve removal of highly resistive fine particles.

Fabric filters (baghouses) have proven to be quite effective in removing fine particles. These units operate like giant vacuum cleaner bags to filter the air before it is released. We are working to improve the performance of these filters by making them more durable, more tolerant of high temperatures, and more capable of controlling fine particles in smaller, less expensive, designs.

Wet scrubbers can also be used to control fine particles. Such units can be very effective. In general, however, their performance drops off as particle size decreases, and the efficiency of the unit is directly related to the amount of energy it consumes. This laboratory is working to improve the effectiveness of wet scrubbers in capturing fine particles (our goal is to achieve a 90 percent capture rate) and to decrease the amount of energy required.

New technology research to improve each of the established particle control systems is underway. This research combines some of the best aspects of each system into one unit. For example, we are testing one such hybrid unit which combines filters with electrical attraction. This, and 40 other novel devices, are being evaluated in a rigorous program to identify and support new ideas for fine particle control.

Data management for a research effort of this scope is no small matter. In fact, early in our efforts we realized that environmental assessment data was abundant, but it was scattered widely throughout the EPA. To solve this problem, we established a computerized database containing information on 1,000 or more environmental impact projects. Now, when an EPA office requires a compilation of the latest information on the environmental, economic and energy impacts of fuel combustion, all they need do is submit a request to our assessment program. They will receive a compilation of all currently available information on the subject.

This capability allows regulators access to the latest environmental and economic information regarding a particular fuel burned in a particular manner. In addition, it helps us to analyze the impacts of alternative policies in terms of energy use. For example, our analysis of the proposed shift from oil to coal indicated that it is financially attractive for a power plant operator to convert from oil to coal even if the costliest pollution equipment is required.

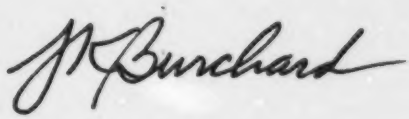
The U.S. Environmental Protection Agency's (EPA's) goal is to protect human health from harmful environmental insult and to help to balance the benefits of industry with its environmental costs. The agency sets standards for healthful air and water and determines maximum acceptable levels of emissions for new sources of pollution. Through its ten regional offices from Boston to San Francisco, EPA enforces, and helps the states to enforce, environmental standards. EPA's research program provides scientific data for this regulatory effort.

The EPA has 15 major research laboratories, located nationwide, and is establishing other research centers at several major universities. These laboratories investigate human impacts upon the environment and the effects of pollutants on human health and property. More than 3,000 research projects are active at any given time, and more than $300-million is invested each year.

Part of EPA's research addresses environmental engineering and pollution control technology. Three EPA laboratories focus on engineering issues — the industrial and municipal research laboratories in Cincinnati, Ohio, and the Industrial Environmental Research Laboratory at Research Triangle Park in North Carolina.

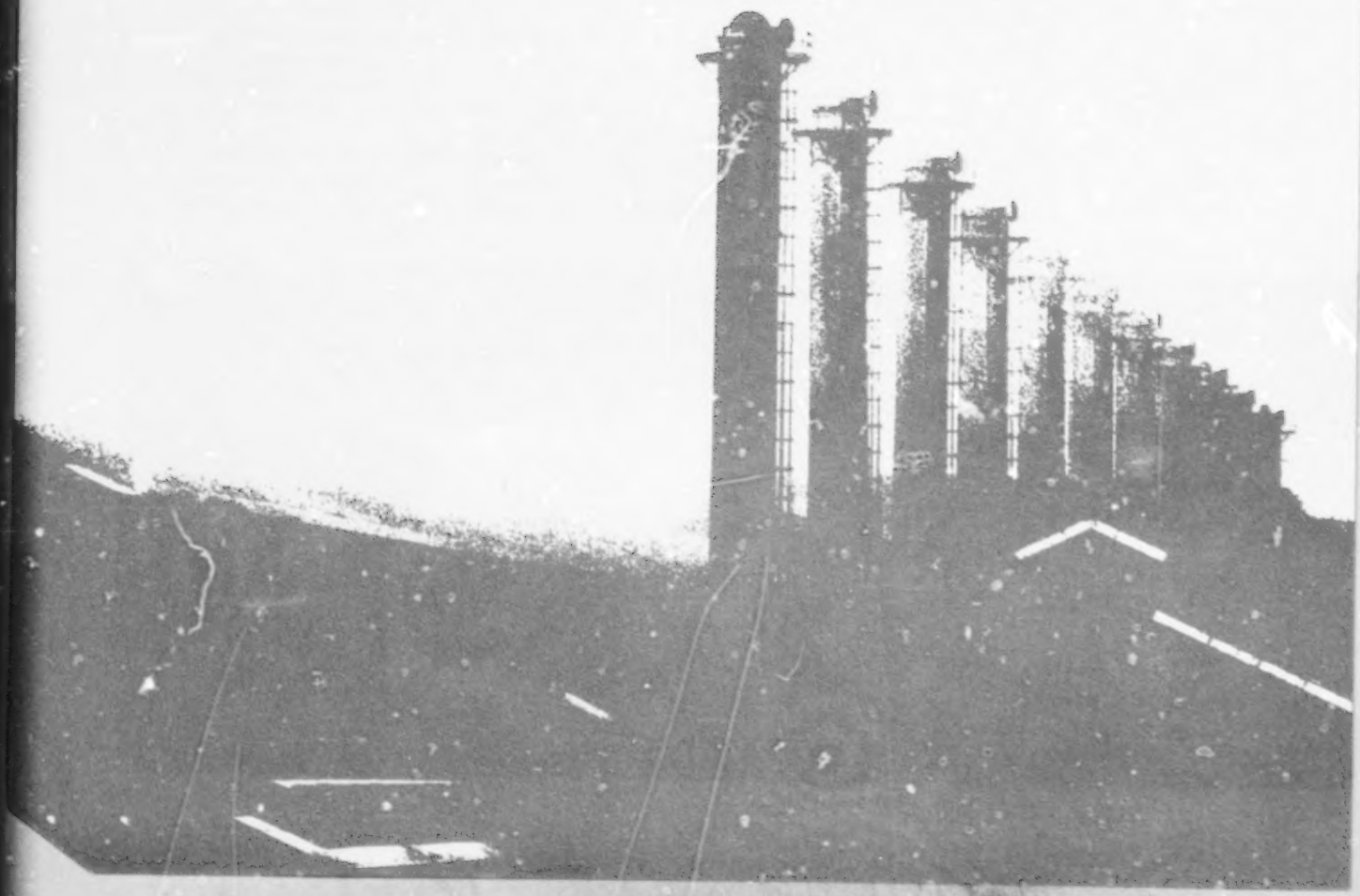
At the North Carolina laboratory we develop and assess control techniques for energy-related pollution. We have been in the forefront of efforts to make the burning of coal less polluting. We have developed new oil burners which are not only cleaner, but are also more energy efficient. We are also working with the textile, chemical, and metallurgical industries to help them to reduce pollution.

I trust that this introduction will provide some insight into our contribution toward the realization of EPA's mission.



Laboratory Director

Industrial Environmental Research Laboratory



Program Highlights

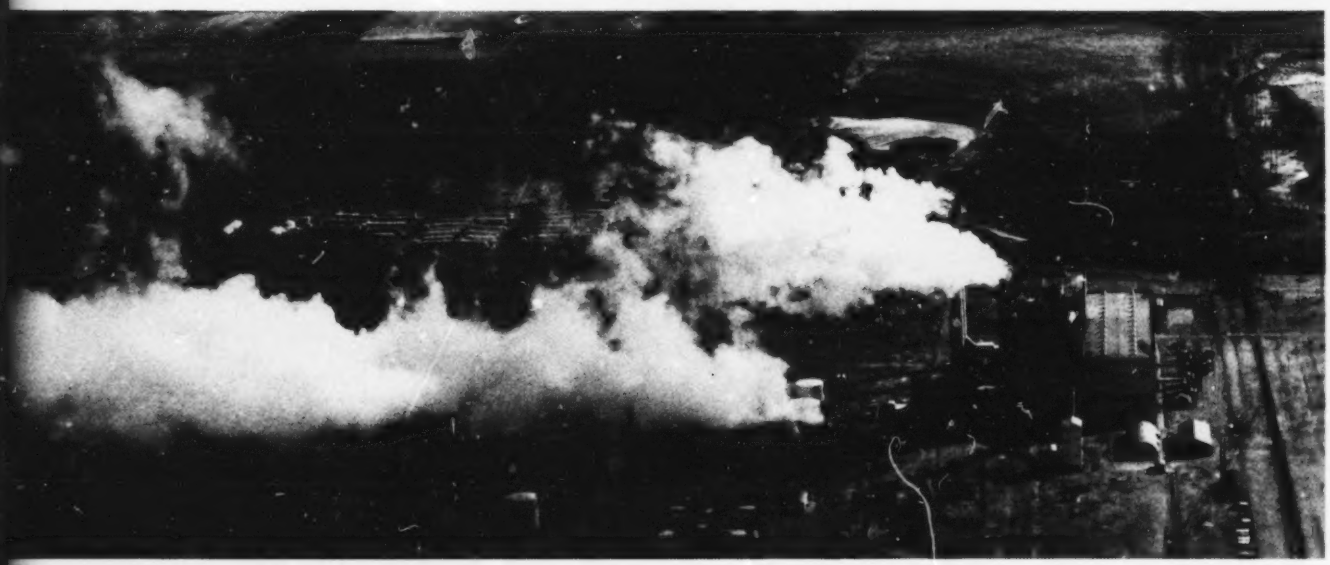
The benefits of our technologically sophisticated economy have brought with them many unexpected costs. The industries which generate power, refine oil, and produce pesticides, steel and textiles also produce unwanted by-products — air and water pollution and wastes. For example, burning coal produces fine particles and gases of sulfur and nitrogen compounds. These pollutants impair breathing, and also contribute to acid rainfall and other damaging precipitation.

We must have an adequate energy supply. We must produce steel, pesticides, textile and refined oil products. But we don't need to sacrifice our health, or that of our environment, in the process. Pollution control technologies, such as those developed by the Industrial Environmental Research Laboratory in North Carolina, will allow us to maintain and expand our economy without sacrificing our environment. Our laboratory is currently working in a number of areas to create, develop, prove and improve pollution control equipment.

Energy production and use, especially the burning of fossil fuels (oil, gasoline, coal, natural gas) is the main source of air pollution in the United States. Such activities produce more than four-fifths of the mass of recognized air pollutants.

To help the United States to use more coal with less environmental damage, we direct much of our effort toward reducing the pollution from coal and other fossil fuels before, during and/or after the fuels are burned.

Cleaner fuels, from domestic energy sources are necessary if we are to meet our energy needs without unacceptable



environmental damage. The carbon and carbon compounds in coal are the main source of its heat value. Most of the impurities in the coal detract from its heating value and/or result in damaging emissions into the atmosphere when it is burned.

One of the ways of alleviating this problem is to remove the impurities from the coal before it is burned. There are three basic ways of accomplishing this. First, you can physically clean the coal. Second, you can chemically clean the coal. Third, you can turn the coal into a synthetic fuel (liquid or gas) removing sulfur in the process. The EPA, through our laboratory, has been in the forefront of all of these precombustion coal treatment processes for almost a decade.

Cleaner burning of fossil fuels depends, to a great extent, upon the manner in which the fuel is burned. This is especially true of nitrogen oxide (NO_x) pollutants.

Through research conducted by this laboratory, EPA has pioneered combustion modification processes which not only dramatically reduce the amount of NO_x pollutants emitted by burning fossil fuels (coal and oil), but also improve the energy efficiency of the processes. NO_x controls for utility boilers are achieving a high degree of commercialization. In 1979 more than 70 units were so controlled and more than 140 units in planning. Other means are being investigated to control sulfur oxides (SO_x) emissions. These means include fluidized bed combustion (being developed by the Department of Energy) and burning pellets made of mixtures of coal and sulfur-capturing limestone.

Less emissions must be achieved if we are to be able to exploit our coal resources for electricity production without very serious health and environmental consequences. Flue gas desulfurization systems (scrubbers), developed and/or tested by our laboratory, are the control technology used on most new coal-burning power plants. Approximately 62 scrubbers are currently in operation at U.S. utility boilers and more than 110 such systems are planned or in construction.

Research is continuing at this laboratory to both improve the cost-effectiveness of these scrubber systems and to reduce or eliminate waste problems.

Research is also in progress on other post-combustion technologies to control fine particles and NO_x emissions from fossil fuel burning.

Industrial processes used by the petrochemical, steel, pesticides, and textile industries are, to a great extent, the foundation upon which much of our advanced economy is based.

These industries are, however, major sources of some of our most problematic pollutants. This laboratory is working closely with industry to develop more cost-effective control technologies, to improve the processes themselves, and to indentify sources of, and controls for, air, liquid and solid waste residuals.

Process measurements provide the accurate data necessary to identify and control pollutants. This is an especially difficult task where, as in this case, our researchers are trying to determine the effects on emissions of small changes in either processes or controls. Our laboratory is studying means of assuring the accuracy of measurement techniques, and of improving the tools available for making measurements.

Cleaner Fuels

There are three points at which pollutants can be removed from, or controlled in, fossil fuel combustion: from the fuel before it is burned, from the fuel as it is being burned, and/or from the exhaust gases. The first of these holds great promise when applied to coal.

The EPA, through this laboratory, has been in the forefront of investigating ways to clean coal. Much of the pioneering work which characterized the cleanability of coals was funded by the EPA and conducted by the Department of Energy.

There is no such thing as a "typical" coal. Coals from different locations will vary greatly in their heat values, moisture content, ash (mineral matter) content and sulfur content. The carbon and carbon compounds in coal are the main source of its heat value. Most of the other substances in coal detract from its heating value and/or produce harmful emissions.

Coal cleaning has several advantages. Cleaned coal produces fewer emissions when burned, so using it can reduce the cost of pollution control equipment. It reduces the bulk of the coal and increases its heat content. This reduces transportation costs. And, the cleaner the coal is, frequently the less maintenance is required by boiler equipment.

Cleaner fuels may be achieved by any of three basic methods. First, it may be physically cleaned. Second, it may be chemically cleaned. Third, the coal itself can be chemically modified to produce synthetic liquid gaseous fuel.

Physical coal cleaning involves crushing the coal to release and remove those impurities which are not chemically bound to the fuel itself. Since each coal is different, each will yield a different percentage of its impurities to the physical cleaning process. Physical coal cleaning is by far the least expensive method available to remove a significant percentage of these impurities,

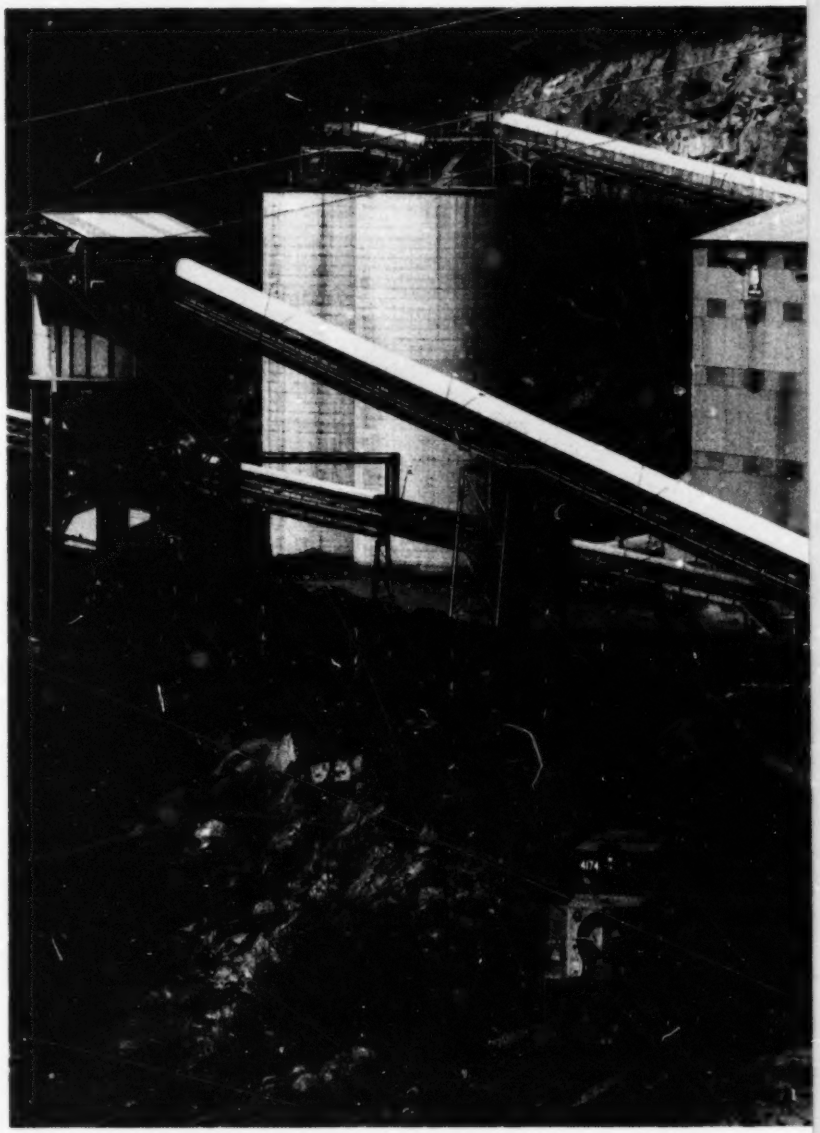
especially sulfur. It will seldom, however, remove more than half of the sulfur present.

The coal cleaning research supported by EPA during the past 5 years has yielded some very beneficial results. For example, based in part upon our research information, an electric utility — Pennsylvania Electric Power Company — has installed a large (1,200 ton-per-hour) coal-cleaning facility to enable its coal-fired power plants to meet air emissions standards. Testing in another of our studies has shown that a device known as a "floatation circuit" holds even greater promise in cleaning high-sulfur coal.

Some of the impurities in coal are weakly influenced by magnetic fields, and we have investigated the possibility of exploiting this characteristic. Using a very strong magnetic field, a method called "high gradient magnetic separation" has shown promise in removing sulfur-bearing contaminants.

Chemical coal cleaning holds greater potential for removing a larger proportion of sulfur and other impurities than does physical coal cleaning because it removes organically bound sulfur as well as mineral sulfur. But, it is also more expensive. Chemical cleaning involves the applications of solvents, heat, and pressure, in varying combinations.

Several processes have been investigated. The hydrothermal process uses elevated temperature and pressures, and a solvent to remove the sulfur. While it is relatively expensive, it is also effective. Another method which has been studied is the "flash desulfurization" process. The coal is heated in the presence of hydrogen to reduce sulfur content by as much as 90 percent. A radically



different approach involves microwave radiation. This process has demonstrated a 75 percent sulfur removal.

Until these coal cleaning processes are proven on a large scale, there will continue to be uncertainties about both their reliability and economics. As such, our research is paving the way to a time when we may need advanced coal cleaning technologies in order to make use of our domestic coal.

Synthetic fuels, either liquid or gaseous, can be produced from coal by various chemical processes. The resultant fuels are not only more useful than coal, they are also cleaner to burn. The environmental concern with regard to synthetic fuels production, therefore lies less with the burning of the fuel than with the industrial processes to produce the fuel.

The potential health and environmental risks of converting coal to oil or gas are several. The by-products of synthetic fuel processes include cancer-causing organic air pollutants, toxic trace metals, and toxic liquid and solid wastes which may find their way into water supplies.

We do not yet have a significant synthetic fuel industry in this country. Hence, we currently have the opportunity to create an industry in which pollution controls are an integral part of the production process. The Laboratory is presently evaluating commercial synfuel processes in the U.S. and abroad to develop control guidance and standards for the emergence of an environmentally sound industry.

Prime Federal responsibility for developing synthetic fuel processes lies with the Department of Energy. The EPA has formal agreements with the Department of Energy which allow us to monitor their synthetic fuel facilities.

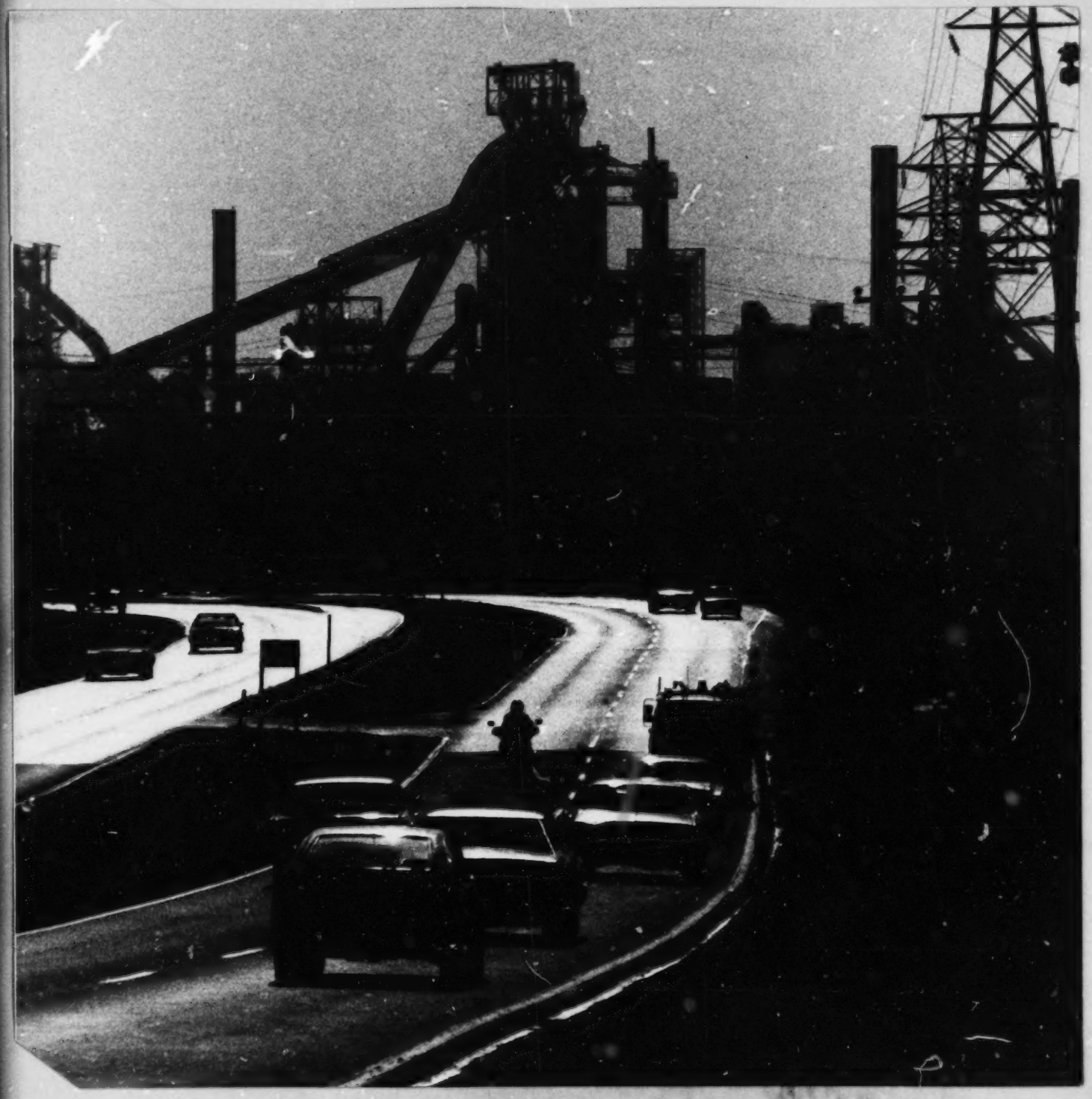
Coal gasification involves producing a gas from coal by reacting coal with air, or oxygen, and steam. The results are a gas containing carbon monoxide, hydrogen, some hydrocarbons and contaminants such as hydrogen sulfide and ash.

Information on the risks associated with these processes is being gathered at two small gasification plants. Preliminary identification of the most problematic of the toxic substances will be used to guide the development of improved control methods.

Direct liquefaction processes produce liquid fuels from coal by direct hydrogenation. Like gasification plants, the by-products of liquefaction plants include some highly toxic substances. Because of the range of technologies and the array of potentially hazardous by-products, more efficient methods for testing samples are needed. Our laboratory is developing rapid tests to determine the potential toxicity of large numbers of waste stream samples.

Indirect liquefaction uses the products of gasification to form hydrocarbon liquids in an additional synthesis step. Techniques like the Fischer Tropach process are the world's only presently commercial means of making transportation fuels.

Many of the problems associated with the wastes and by-products of coal liquefaction processes could be solved if some way were developed to make these by-products harmless or useful. This laboratory is investigating alternatives to produce marketable by-products and to recover or destroy the pollutants associated with these processes.



Cleaner Burning

The point at which a fuel is burned is the point at which pollutants are created and/or released. It makes sense, therefore, to investigate methods to capture or control pollutants as the fuel is being burned. We at this laboratory are investigating several methods of cleaning up the combustion process.

Sulfur and its derivative compounds are not the only serious pollutants to result from the burning of coal and oil products. Nitrogen oxides (NO_x) are also produced in large enough quantity to cause serious environmental disruption. For example, half or more of the acidic component of acid rain is a direct result of NO_x emitted into the atmosphere. Acid rain, snow and dry acidic fallout are suspected of damaging fisheries, property and certain crops. In addition, NO_x causes changes in the lungs and lowers resistance to respiratory infections.

Nitrogen itself is not a pollutant — in fact, 80 percent of our atmosphere is nitrogen. However, this element can combine with oxygen to form NO_x, which is a pollutant. The burning of fossil fuels creates NO_x in two main ways. First, many fuels have nitrogen in them which can combine with oxygen when the fuel is burned. Second, at high temperatures the nitrogen in the atmosphere can oxidize to form NO_x.

Design modifications: Against this background, the research conducted at our laboratory over the past 5 years shows that it is possible to reduce NO_x emissions while either not affecting or improving energy efficiency. For example, an experimental pulverized coal burner developed by our laboratory not only reduces NO_x emissions by as much as 85 percent, but also may improve energy efficiency. This burner is based upon "staged combustion," a design which distributes the mixing of air and fuel into stages or zones.

Staged combustion burns the coal in three combustion zones. The first stage is low in both temperature and oxygen, thus minimizing both fuel-generated and thermally-generated NO_x. The second and third combustion zones receive additional oxygen to achieve complete combustion of the carbonaceous matter and to allow fuel heat recovery. Full scale field evaluation of these burners is being carried out at present.

We have conducted similar tests on gas- and oil-fired utility boilers. These tests indicate that nitrogen oxide emissions can be reduced by more than half using various modifications. Field tests of the two most promising techniques — staged combustion and exhaust gas recirculation — showed

reductions in NO_x emissions of up to 80 percent. EPA is cooperating with the Department of Energy to field test existing units in order to lay the ground-work for development and application of controls for stoker-type boilers.

Utilities and industries are not the only ones to benefit from our research. Applying advanced design principles to residential oil-fired furnaces, we have developed a warm air furnace which reduces the NO_x emissions while increasing fuel efficiency. Field tests of these new units resulted in an average efficiency of 75 percent and a reduction in fuel consumption of over 15 percent.

Pelletized coal: Another way of removing pollutants from coal involves capturing them at the instant they are released by the combustion process. For example, sulfur pollutants will react with some substances to form stable, easily removed solid waste. One of these "scavenger" substances is common limestone. When sulfurous emissions (SO_x) come in contact with properly prepared limestone there is a chemical reaction which turns the sulfur pollution from a gas into a solid.

Based upon this principle, we are investigating the possibility of forming pellets made up of crushed coal and limestone. Our preliminary tests have shown that these pellets enhance the efficiency of the combustion process and can reduce the need for post-combustion control technology equipment (scrubbers). Tests have shown that burning the coal/limestone pellets produces a reduction in sulfur emissions by as much as three quarters.

Our research into coal/limestone pellets continues. Although we do not yet know exactly how the coal/limestone pellet captures sulfur, we do know that without a doubt, it does work. Pelletized coal could provide a very important alternative form of coal combustion pollution control technology. This alternative is relatively simple and could prove to be substantially less expensive, especially in terms of capital costs, than alternative control methods.

Fluidized bed combustion is another approach to controlling SO_x. The reason that this process is called "fluidized bed" is because air is bubbled up through a burning coal/limestone mixture giving it the appearance of being fluid.

Fluidized bed systems can remove the major portion of the sulfur oxides produced during combustion, and the lower temperatures at which these systems operate can result in a 50 percent reduction in NO_x emissions. However, the fluidized bed process will need further development to be competitive with other forms of NO_x control.

At present, we continue to analyze emissions from four fluidized bed units. One of our major concerns with this technology is with the waste products of the fluidized bed process. Effective disposal methods will be necessary to control or use these wastes.

Catalytic combustion is an advanced process which appears to offer very low pollutant levels. In this process, a chemical catalyst is used instead of a burner. The fuel, when oxidized, releases its heat within the catalyst bed. While still very much in the early stages of experimentation, initial results show the potential for near zero production of NO_x emissions.

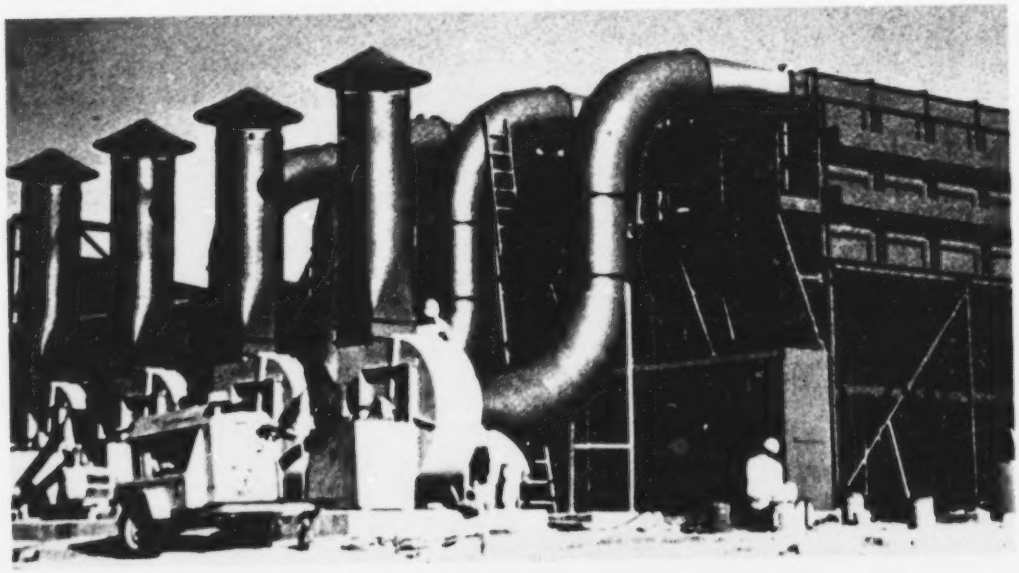
Less Emissions

Perhaps the most successfully applied pollution controls for coal burning plants are those which clean exhaust gases. These technologies — scrubbers, precipitators, and baghouses — are in wide use today. They remove one or another of the three major air pollutants: sulfur oxides (SO_x), nitrogen oxides (NO_x), and particles. The first two of these pollutants are a major source of acid rain and visibility degradation. The third, fine particles, are suspected of being harmful to health and of contributing to haze and poor visibility.

Much of the EPA's research has focused upon controlling SO_x emissions. Perhaps our most important contribution in this area has been improving the flue gas scrubber. The scrubber system captures sulfur compounds produced during combustion and keeps them from being emitted into the atmosphere. Without flue gas scrubbers, we could not shift to burning more coal without seriously degrading our air quality.

There are several types of scrubbers, but all fall into one of two categories: they either produce a liquid (sludge) or solid waste which must be disposed of, or they produce some by-product such as elemental sulfur, which can be marketed as a commercial product.

Nonregenerable scrubbers, the ones which produce a waste product, are the most widely used type of flue gas desulfurization system. Most of the systems are of the lime/limestone type. In these scrubbers, the flue gas is circulated through a spray or cascade of crushed lime or limestone and water. The SO_x in the flue gas reacts with the lime/limestone to produce a waste sludge.



Several aspects of the lime/limestone system could be improved. The effectiveness of SO_x removal is only 80 percent. The systems require twice as much lime/limestone as theoretically necessary, therefore producing additional waste. Finally, the waste is somewhat difficult to handle.

EPA researchers are working to relieve these shortcomings. In cooperation with the Tennessee Valley Authority (TVA), experimenters have tested additives which both improve scrubber performance and lower overall costs and energy demand.

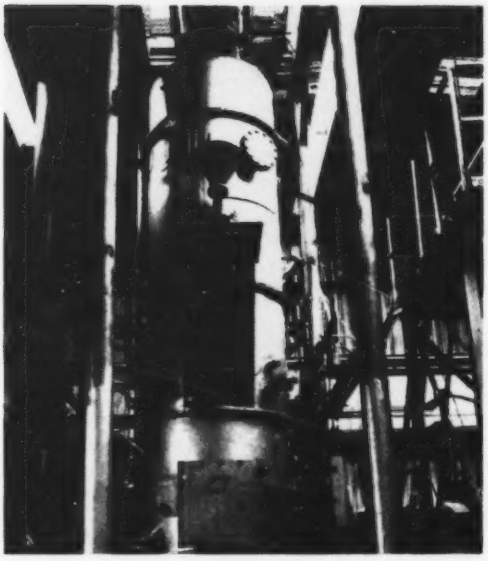
Many techniques have been first tested on one of the two model lime/limestone scrubbers located in this laboratory. These 18-foot (5.5 meter) high models duplicate all of the major components of a full-sized scrubber, but are designed especially for such experimenting. We can, for example, conduct tests with these units which would be impractical or prohibitively expensive on a full-scale unit. In addition to improving existing scrubber technology, our research is developing alternatives. The goal of our efforts is a system which will be capable of 95 percent SO_x removal and 98 percent limestone utilization, thus producing less sludge.

Scrubber sludge disposal is one of the key problems with lime/limestone systems. Current practice is to dispose of the sludge, which has the consistency of toothpaste, by dumping it into lined ponds to prevent seepage of the liquid component into the water supply. This can account for as much as one-quarter of the overall cleanup costs. One process we are investigating in cooperation with TVA may provide the means whereby sludge can be turned into useful landfill. Another type of scrubber promises to simplify the waste disposal process by producing a solid, rather than a sludge waste.

All nonregenerable scrubbers produce wastes. There are, however, systems under development which "regenerate" their sulfur-capturing material and produce marketable by-products, such as elemental sulfur. These are called regenerable processes.

Regenerable processes have been shown capable of removing as much as 95 percent of the sulfur compounds from flue gas. The end product of several of these processes is elemental sulfur. The scrubbing process is a closed loop with no significant additional amount of waste being generated by the system.

Two regenerable scrubbing processes are currently being investigated by the EPA. One of these is being developed in cooperation with the Northern Indiana Public Service Company. This system has consistently achieved approximately 90 percent removal of SO_x and a low level of particle emissions.



Removing NO_x from exhaust is possible, but the technologies to do it are not yet commercially available. The most promising process reacts ammonia with NO_x in the presence of a catalyst to form harmless nitrogen gas and water vapor. The process can reduce NO_x emissions by 90 percent. In Japan, this technology has been applied to large scale gas and oil-fired sources and is being tested on coal-fired sources. EPA is evaluating it, as well as a technology to simultaneously remove both NO_x and SO_x on a pilot plant at a coal-fired utility boiler.

Particle control systems have been in use for decades. Unfortunately, most of these systems only remove the larger particles and let the smaller, or fine, particles escape.

The concern over fine particles is twofold. First, fine particles (smaller than half the diameter of a human hair) are so small that they can bypass the body's natural filtering system and, therefore, be breathed deeply into the lungs. There they can lodge and cause innumerable difficulties. Secondly, fine particles serve as nuclei on which the toxic metals vaporized in combustion processes can condense. Such condensation exaggerates the biological impact of these metals.

Three main types of equipment are used to control particles — electrostatic precipitators, filters (baghouses), and wet scrubbers. This laboratory is supporting efforts to improve the effectiveness and reduce the costs of all three technologies.

Electrostatic precipitators work because the particles in flue gas can be given an electrical charge. Once a particle is electrically charged, it can be attracted to an oppositely charged plate and, from there,

Industrial Processes

Hundreds of thousands of industries are located throughout this country. Each one, depending upon the products it produces and the methods it uses, may or may not be a source of hazardous or environmentally damaging pollution. Responsibility for developing control methods for industrial processes is divided between this laboratory and our sister industrial environmental research laboratory in Cincinnati. Our laboratory concentrates on iron and steel making, textile and pesticide manufacture, petrochemical and petroleum refining.

Petroleum refineries with their hundreds of miles of pipes, thousands of valves, and their hot, high-pressure processes, have the potential for being major sources of air pollution. One of our recent studies of 14 oil refineries revealed thousands of potential or actual sources of emissions. This study produced important results. It provided the scientific data necessary to support the development of reasonable pollution control standards for refineries.

Pesticides, because they are designed to kill things, can become, or their by-products can become, serious environmental and health hazards. For example, although the use of DDT was banned in 1972, the fish in Lake Michigan still contain unsafe levels of that pesticide. This laboratory is concentrating its pesticides-related research on the water pollution problems and controls, and on disposal of hazardous solid wastes. In addition, cooperative efforts with the National Institute of Occupational Health and Safety are assessing air pollution levels and controls for pesticides manufacturing.

Textile manufacturing plants in this country number approximately 7,000. These plants generate more than one billion gallons of wastewater each year. For the past several years, this laboratory has been working closely with representatives of the textile industry to test alternative pollution control technologies at various textile plants. Since each textile plant waste stream is different, the most appropriate control technology configuration for each must be adjusted accordingly. Through these efforts, we have been able to design optimum control techniques which not only clean up the waste stream but, in some cases, allow for the recovery and recycling of water and other process resources.

Steel production is one of the major industry sources of pollution, generating significant quantities of pollutants including particles, SO_x, carbon monoxide, cyanide, ammonia and heavy metals.

For more than a decade, EPA research has been working to identify the most problematic sources of pollution in the steel industry, and to develop cost-effective controls or alternative cleaner processes. We found that the most polluting process was that by which coal was turned into coke, which is used to make iron. The particulates produced in the "coking" process were found to contain carcinogenic material, and coke oven workers display a higher than would be expected rate of lung cancer.

We are also looking at the pollution problems created by the many other operations involved in making iron and steel. Significant among these problems is water pollution. Now active is a pilot scale study of the treatability of coke plant and blast furnace wastewaters.

Hazardous waste disposal is now recognized as an extremely serious environmental problem. Abandoned or improperly disposed of hazardous wastes have contaminated drinking waters, driven people from their homes, and even caused several deaths. Research supported by EPA has tested and proven effective one possible solution to this problem: at-sea incineration.

Many hazardous wastes are, unfortunately, rather stable substances which are not easily made harmless. One of the most reliable ways of disposing of hazardous wastes is to burn them at high temperatures. However, many hazardous wastes break down into substances which, while far less toxic than the original waste, must still be controlled. Hence, an incinerator located on the land might require additional pollution control devices to be installed to clean its exhaust gases.

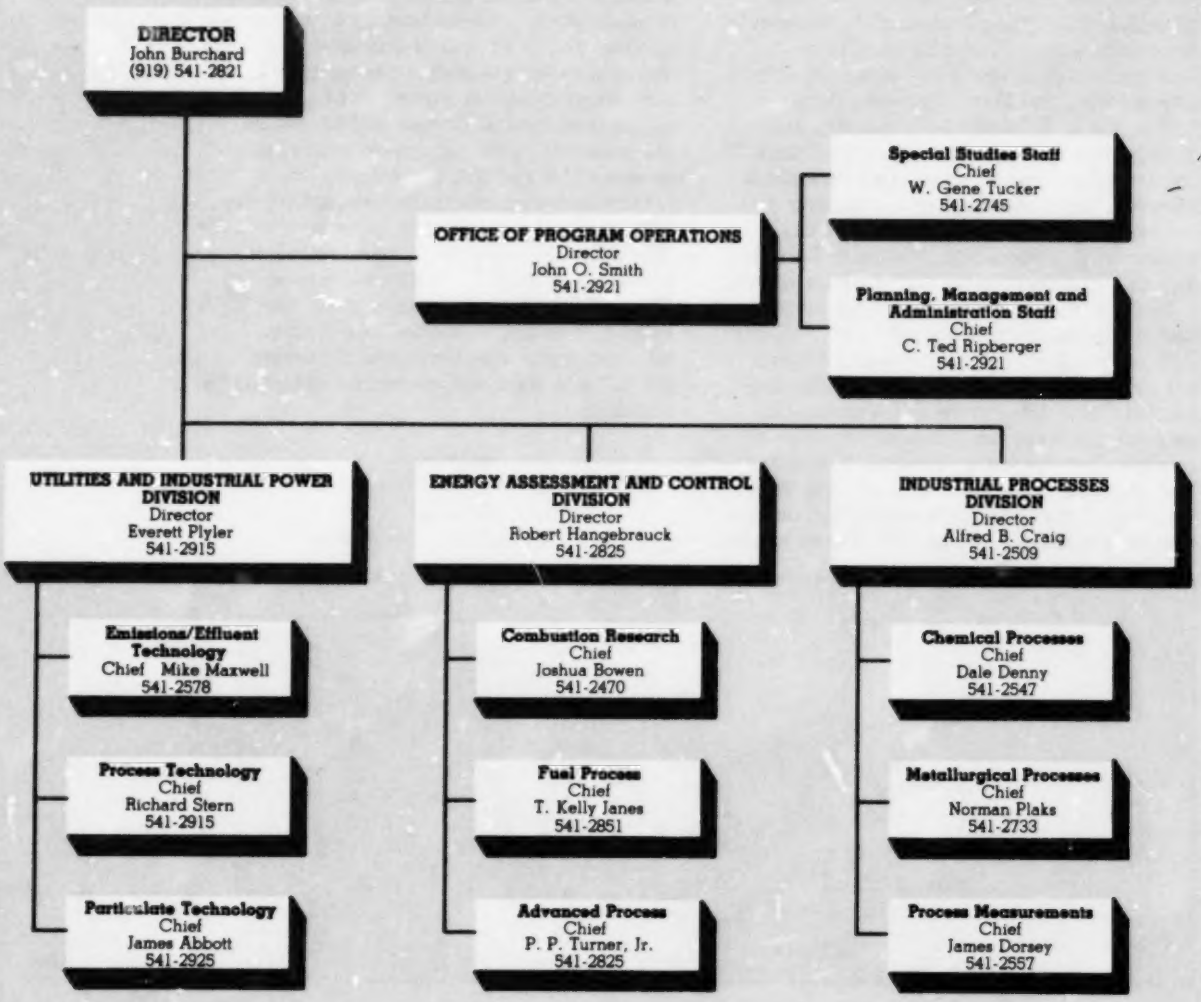
Locating an incinerator at sea — away from populous areas — offers one near term means of eliminating some of our hazardous wastes. Our laboratory is studying both stationary incinerator platforms at sea and incinerator ships.

Accurate measurements are the cornerstone upon which both our scientific advances and our regulatory decisions are ultimately based. We must have assured, precise and repeatable measuring and sampling techniques. For example, in order to tailor pollution controls to the exact needs of an industry, we must know precisely what types of pollutants are produced and when they are produced.

To provide this type of support, the laboratory has an extensive process measurements program. This program directly supports our environmental assessment efforts. Samples are taken of various industrial effluents, these samples are analyzed for hazardous properties and, if necessary, a long-term monitoring effort is established. The process measurements program also supports EPA's regional offices by developing strategies for evaluating both water effluents and particle control devices for air pollution.

The Organization

Research Triangle Park
North Carolina



Industrial Environmental Research Laboratory

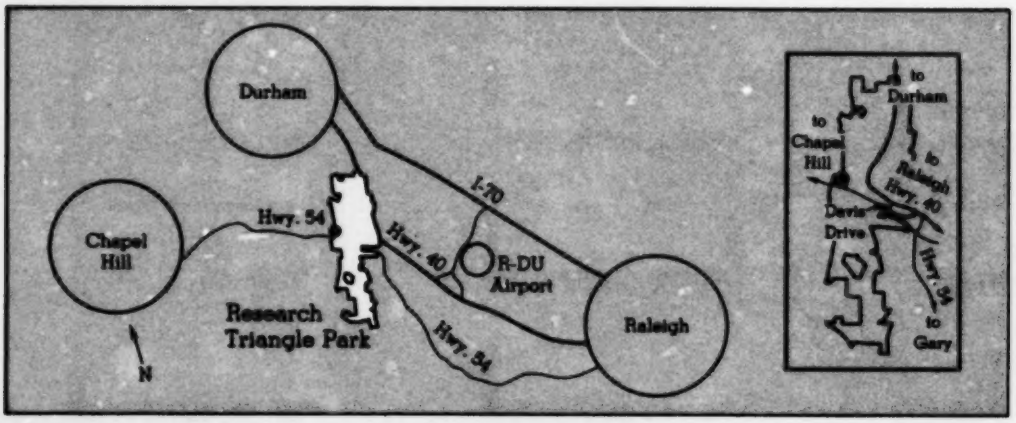
The Industrial Environmental Research Laboratory, along with three other EPA laboratories, is located in Research Triangle Park, North Carolina. The largest planned research center in the country, the Park occupies about 15,000 acres midway between three universities: Duke University in Durham, the University of North Carolina in Chapel Hill, and North Carolina State University in Raleigh. Both industry and government are represented in the Park's 28 research facilities. Peer group interactions between the academic, industrial, and government sectors in this setting give the Industrial Environmental Research Laboratory a broad perspective for its own research.

There are close ties between the laboratory and the three universities affiliated with the Park — many of the laboratory's scientists act as adjunct professors at one of the universities. The laboratory also encourages external participation in its environmental research by awarding research contracts and cooperative agreements. In fact, the majority of the laboratory's pollution control research is done extramurally. For example, the laboratory is working with electric power generating plants to build pollution control demonstration units.

The laboratory itself has unique in-house research facilities, particularly in the areas of combustion modification, fine particulate control, and in sampling and analytical techniques, and is widely recognized for its work in air pollution control technology. With an average annual budget of $40 million, the laboratory's 85 employees coordinate between 200 and 250 active projects.

More specific information regarding the laboratory's research may be obtained in the "ORD Program Guide," "Research Highlights," and the "Controlling Nitrogen Oxides" Research Summary. Also, the "EPA Publications Bibliography" is a listing of publications in specific areas of research. All of these publications can be obtained by writing to:

Publications
CERI
U.S. EPA
Cincinnati, OH 45268



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Industrial Environmental Research Laboratory

Research Triangle Park
North Carolina